satellite is synchronized with GPS time, the time of arrival of the base station signals and the time of arrival of the satellite signals can be used together to form a TDOA value that can be used in a least mean square TDOA equation, as is well known in the art. It will be understood by those skilled in the art since the satellite signals and the base station signals are synchronized, the relationship between the pilot PN sequence that is transmitted from the base stations and the satellites is known. Accordingly, without knowing the exact time at which the signals were transmitted from either the base stations or the satellites, the time at which the base station signals were transmitted with respect to the time at which the satellite signals were transmitted is known. Therefore, the time difference of arrival can be accurately determined by subtracting the arrival times of any signal from either a base station or satellite from any other signal received from either a base station or satellite.

Asynchronous GPS/forward Link Mode

As is the case in the synchronous GPS/forward link mode, the asynchronous GPS/forward link mode assumes that all base stations are synchronized to one another. However, in the asynchronous mode, the time of arrival of signals received over the forward link cannot be combined with the time of arrival of the GPS signals to generate meaningful TDOA measurements, as can be done in the synchronous GPS/forward link mode. Rather, the time of arrival of signals received from base stations can be combined with only the time of arrival of signals received from other base stations to form TDOA measurements. Likewise, the time of arrival of signals received from GPS satellites can be combined with only the time of arrival of signals received from other satellites to form TDOA measurements.

Nonetheless, if a wireless communication device can receive signals from N base stations (where N is equal to at least two), then all that is needed are signals from **4**–N–**1** satellites. Any additional satellites that can be received would provide an over-determined solution, thus leading to a more reliable and accurate solution. It should also be clear from the present disclosure to those skilled in the art that two or more non-synchronous systems may be combined in order to reduce the number of satellites needed to **4**–(N_1–N_2. . . –N_x)–X, where there are X systems in addition to the satellite system, each such system having at least one base station that can be received by the wireless communication device, and N base stations can be received for system x.

In addition, the procedure for determining the differences between internal BS delays in the asynchronous GPS/forward link mode differs from the procedure used in the synchronous GPS/forward link mode due to the fact that the base stations are not synchronized to GPS time. In the case of asynchronous GPS/forward link mode, a receiver receives signals from at least two of the base stations within the communication system. The receiver is placed in a known location so that the TDOA between the signals transmitted from each pair of two base station is known. Accordingly, the difference between the known value of the TDOA and the measured value of TDOA is equal to the difference in the internal BS delays (and any clock offsets between the base stations). For each pair of base stations, such a measurement is made. These differences are then either stored in, or communicated to, the wireless communication device **20** to be taken into account when calculating the TDOA values. Alternatively, these differences can be either stored in, or communicated to the WPF **18** to which the TDOA measurements from the wireless communication device **20** will be sent. In that case, the WPF **18** corrects the TDOA to account for errors in the synchronization between the base stations. If the calculated values are communicated, they may be communicated at the time a new base station is commissioned, at regular intervals, on demand, or upon a change in the values.

The GPS/forward link modes described herein treat each base station as a "pseudo satellite". A pseudo satellite is defined as a device that transmits a signal synchronous with the satellites and which can be used in a TDOA measurement with a satellite. The WPF **18** stores base station almanac, including base station location, antenna high, antenna characteristics (antenna pattern and gain), base station configuration, such as number of sectors, orientation of sectors, clock error for each sector. In this way, the location system will consider all received signals by the wireless communication device to have one common time reference (i.e., GPS time as the reference for all received signals). It should be noted that the presently disclosed method and apparatus may use both forward and reverse link measurements if they are available. That is, similar measurements made at a plurality of base stations based on signals transmitted by the wireless communication device could be used instead of, or in addition to, the signals received by the wireless communication device. The same technique would apply. However, the time of arrival information would have to be transmitted to a common location so that differences in the relative arrival times at each base station of the signal transmitted from the wireless communication device could be determined.

The disclosed method and apparatus has been described herein with reference to a particular embodiment for a particular application. Those having ordinary skill in the art and access to the present teachings will recognize additional modifications, applications, and embodiments within the scope of the present invention. It is therefore intended by the appended claims to cover any and all such applications, modifications, and embodiments within the scope of the present invention.

What is claimed is:

1. A wireless communication device for determining the search window center for searching for a global positioning system (GPS) satellite, including:

a) a receiver for receiving signals from a base station, the signals including an indication of the timing of a GPS satellite;

b) a GPS receiver/time unit; and

c) a control processor, coupled to the receiver and to the GPS receiver/time unit, and configured to use the received timing of the GPS satellite to determine a search window center in time to expedite a search for that satellite;

wherein the search window center is further determined using the particular sector within the base station through which the base station is communicating with the wireless communication device.

2. A wireless communication device for determining the search window center for searching for a global positioning system (GPS) satellite, including:

a) a receiver for receiving signals from a base station, the signals including an indication of the timing of a GPS satellite;

b) a GPS receiver/time unit; and

c) a control processor, coupled to the receiver and to the GPS receiver/time unit, and configured to use the received timing of the GPS satellite to determine a search window center in time to expedite a search for that satellite;